Review Article

Distal Humerus Fractures in the Elderly Population

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Abstract

Distal humerus fractures present complex challenges in the elderly patient. These fractures often occur in patients who are living independently but have poor bone quality and low physiologic reserve, thus complicating management decisions and treatment. The goal is a painless, functional, stable elbow that allows completion of the activities of daily living. Nonsurgical management is reserved for those who cannot tolerate surgery. Open reduction and internal fixation is the preferred choice in fractures amenable to rigid fixation and early motion. Although total elbow arthroplasty provides improved early function and similar overall outcomes in appropriately selected patients, it has the potential to cause devastating complications. With modern technology and treatment principles, as well as early definitive treatment by an experienced specialist, predictable return to function can be expected.

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Distal humerus fractures (DHFs), especially those occurring in the elderly population, remain among the more complex injuries treated by the orthopaedic surgeon. These patients often present with poor bone quality, and the fractures frequently involve complex intra-articular comminution. Such patients may have suboptimal rehabilitation capacity, low physiologic reserve, and poor soft-tissue envelopes. Careful consideration of these factors is paramount in decision making and execution of treatment. The elbow permits the positioning of the hand in space, allowing a person to reach the face, midline, and perineum, thus facilitating activities of independent daily living, such as feeding, hygiene, and self-care. Therefore, the goal of treatment is to safely provide a painless, stable elbow with a functional range of motion (ROM; [flexion arc of 30° to 130°]) to allow functional independence.

Epidemiology

Having a bimodal distribution, DHFs represent 2% of fractures, primarily affecting young males as a result of high-energy trauma, frequently from a motor vehicle crash, and elderly females as a result of low-energy trauma, usually a ground-level fall.[1] The incidence of DHF is expected to triple by 2030 in all age groups and to increase even faster in persons aged >80 years.[1,2] DHFs represent a significant threat to the autonomy of the elderly. Charissoux et al[3] noted that patients with a DHF primarily are independently living, active females. The review noted that 86% of patients were living independently at home at the time of injury, with 99% of the studied cohort requiring hospitalization of ≥10 days and nearly 90% requiring surgical treatment as a consequence of the fracture.[3]

Figure 1

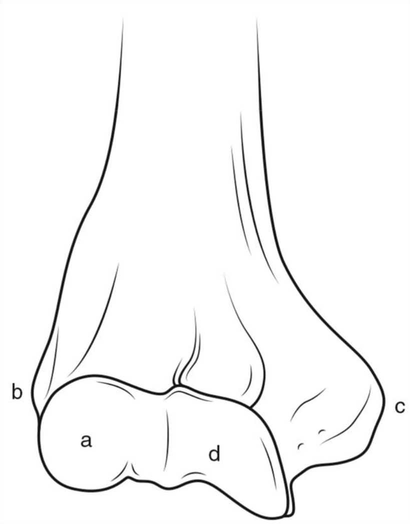


Illustration demonstrating distal humerus osteology. The lateral column ends at the capitellum (a), which sits anterior and distal to the lateral epicondyle (b). The medial column ends at the medial epicondyle (c), and the trochlea (d) spans between the capitellum and the medial epicondyle.

Anatomy

The elbow is a trochoginglymoid joint that allows rotation (trochos [Greek]: "wheel") through the radiocapitellar joint and hinge-like (ginglymoid [Latin]: "hinge") motion through the ulnohumeral joint. The distal humerus is composed of medial and lateral divergent columns with an intervening trochlea at the articular surface that acts as a tie arch. Shaped like a spool, the trochlea (Greek: "pulley") is the most crucial structure for restored function and stability[4] (Figure 1).

Classification

The distal humerus is defined by a square with a width that is the distance between the epicondyles on the AP radiograph and a height that is perpendicularly measured in a proximal direction from the distal articular surface. The AO/OTA classification is the accepted means of communication, describing fracture pattern, location, and degree of articular involvement.[5] Type A fractures are extra-articular, type B are partial articular, and type C are complete articular injuries that maintain no continuity with the diaphysis. Reporting on 320 patients of all ages, Robinson et al[1] showed a fracture distribution for type A, type B, and type C fractures of 39%, 24%, and 37%, respectively. A 7.2% incidence of open fractures was seen, with most being type C patterns. Specifically evaluating elderly patients, Charissoux et al[3] reviewed 410 patients aged ≥65 years and found a trend toward the more complex fractures, with a 67% incidence of type C fractures and a 16% overall incidence of open injuries.

Patient Evaluation

Physiologic age, independence, activity level, and mental status are the predominant characteristics driving treatment considerations. Most DHFs result from ground-level falls involving direct trauma to the elbow.[1] Predisposing factors, such as arrhythmias, visual impairment, anemia, stroke, polypharmacy, and alcohol use, should be ruled out. The clinical examination must rule out additional injuries and document neurovascular status. Careful inspection of the skin must be performed to establish the presence of any subtle open fractures.

Radiographic imaging of the elbow should include AP, lateral, and radiocapitellar views as well as orthogonal views of the proximal and distal joints. Routinely obtaining traction views has fallen out of favor but can be useful in the sedated patient. If significant articular involvement is present, a CT scan with three-dimensional reconstruction can help with understanding the fracture pattern and with formulating surgical tactics.

Initial Management

Initial management consists of splinting, application of ice, elevation, and early motion of the fingers and wrist. Emergent reduction can be considered for significant displacement, skin tenting, or neurovascular compromise when surgical intervention will be delayed. Most patients benefit from inpatient care, with concomitant participation by orthopaedic and medical teams with expertise in the care of geriatric patients; fragility workup with the assistance of a bone health coordinator is recommended.

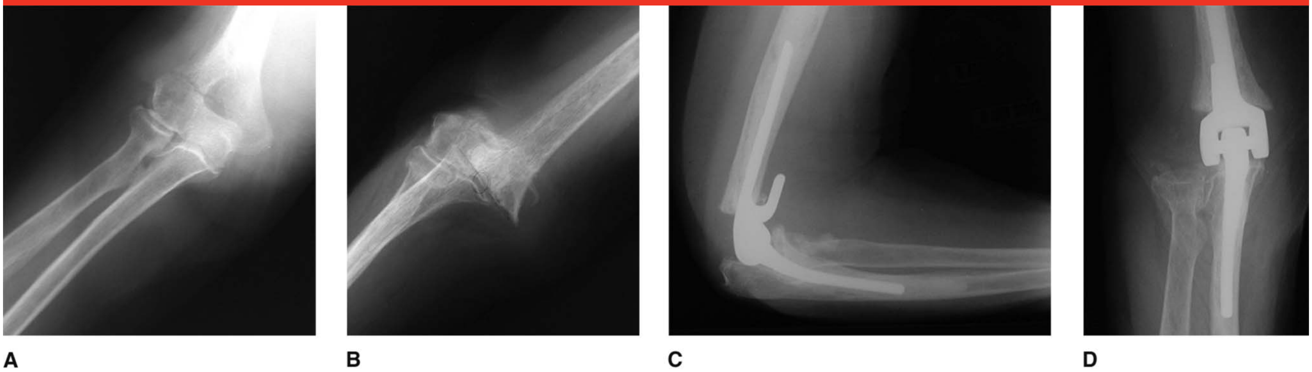
Open fractures must be treated with early antibiotics, tetanus update, and urgent irrigation and débridement in the operating room. In a case-control study, Min et al[6] reported that open fractures have a notably worse prognosis than closed fractures. However, multiple authors have shown that early definitive management, with either osteosynthesis or arthroplasty, is safe and should be the standard of care when the soft-tissue envelope and resources allow.[6,7]

Nonsurgical Treatment Options

History

Up to the mid-20th century, nonsurgical treatment of DHF was preferred because of inadequate internal fixation techniques. The "bag of bones" technique, credited to Hugh Owen Thomas and later popularized by Sir Robert Jones, was first published in 1937 in the modern English literature by W.J. Eastwood.[8] Eastwood[8] described collar and cuff

Figure 2



A, AP radiograph of the elbow showing a nondisplaced low-transverse distal humerus fracture in a healthy, active 80-year-old woman who fell while exiting a bathtub. **B**, AP radiograph of the elbow showing displaced nonunion after 18 months of nonsurgical management. AP (**C**) and lateral (**D**) radiographs showing a stable total elbow arthroplasty at 24 months postinjury. The patient reports resolution of pain and return to function.

management, placing the elbow at 60° to 90° of flexion, with or without reduction, followed by early upright activity. Gentle active motion of only the elbow began at 2 weeks and advanced to unlimited active motion of the elbow and shoulder at 6 weeks; following this protocol, 12 of 14 patients returned to their original occupation, demonstrating a 15° to 60° loss of extension.

Indications and Contraindications

Although nonsurgical management has been largely abandoned, it still has a role in the treatment of patients who are medically or mentally unfit, have poor preinjury function, or demonstrate poor compliance. Other extenuating circumstances, such as severe soft-tissue compromise, may also warrant a trial of nonsurgical management, with definitive management added later, when appropriate. Nonsurgical management is contraindicated in young, active patients, and in those who are able to safely undergo surgery. Patients who later clinically improve or in whom nonsurgical management fails can safely undergo arthroplasty on a delayed basis.

Risks and Benefits

The risks of nonsurgical management include stiffness, instability, poor function, pseudarthrosis, pain, and soft-tissue problems (Figure 2). The major benefits are the avoidance of any surgical risks, potentially shorter hospital stays, and the avoidance of wound complications and implant failure.

Outcomes

Aitken et al[9] conducted a retrospective review of 40 elderly, high-risk, low-demand patients with DHF treated nonsurgically, instituting early ROM as tolerated. Improvements were noted in the Broberg and Morrey scores from 42 points (poor) at 6 weeks after injury to 67 points (fair) at 12 weeks ($P < 0.001$). The mean Oxford Elbow Score was 30 points (fair; [48 = excellent]) at 4-year follow-up, and the Quick Disabilities of the Arm, Shoulder and Hand score averaged 38 at the same interval. Clinical examination revealed that 95% of patients available for follow-up were able to reach their mouth and perineum and were considered to have a functional ROM. However, 5 of 40 patients (12.5%) underwent early elective fragment excision, and 15 of 34 patients (44.1%) had nonunion at 1 year and underwent subsequent surgery. Desloges et al[10] noted better results in a similar patient population, reporting that 13 of 19 patients (68%) examined clinically had good to excellent subjective outcomes, with an average Mayo Elbow Performance Score (MEPS) score of 90 at a mean follow-up of 27 months and an average ROM of 22° to 128°; of those patients with adequate radiographic studies, 22 of 27 (81%) achieved radiographic union by 12 months.

Open Reduction and Internal Fixation

History

With the introduction of the AO principles of rigid internal fixation and early functional rehabilitation, fixation techniques and implant options continued to evolve throughout the mid- to late 20th century. These developments caused a shift in the treatment paradigm toward internal fixation. In a retrospective review in 2003, Robinson et al[1] showed a 5.8 times greater relative risk (RR) of nonunion and a

Table 1

Open Reduction and Internal Fixation for Distal Humerus Fractures in the Elderly Population: Pooled Outcomes Analysis[a]

Variable	Ratio or Range	Average or Percent
Age[11,13-19]	61–100 yr	75.3 yr
Follow-up[11,13-19]	—	47.8 mo
Open fracture[11,13-15,18]	29/153	19%
Preoperative nerve changes[11,13-16,18]	10/106	9.4%
New postoperative ulnar nerve changes[11,13-16,18]	16/222	7.2%
ROM[11,13-19]	19.4° to 126.1°	102° arc
MEPS[17-19]	—	83%
Hardware failure[14,15,17-19]	19/220	8.6%
Nonunion[11,14-16,18,19]	6/222	2.7%
Heterotopic ossification[11,13,18,19]	16/222	7.2%
Olecranon osteotomy nonunion[11,14-16,18,19]	3/110	2.7%
Olecranon ROH[13,15]	4/31	12.9%
Surgical time[13,17,18]	—	151.8 min
Length of stay[11,13,14,16-18]	—	8.8 d
Superficial wound problems[11,13,14,16-18]	12/175	6.9%
Radiographic arthritis[13-15,18]	49/78	62.8%

MEPS = Mayo Elbow Performance Score, ROH = removal of hardware, ROM = range of motion
[a] Data pooled from 222 patients

4.4 times greater RR of delayed union in 47 DHFs treated nonsurgically compared with 273 DHFs treated surgically, and a 3.9 times greater RR of union complications was found in open DHFs compared with closed fractures (odds ratio, 3.9; 95% confidence interval, 1.9 to 8.2). The authors specifically pointed out that “low” type A and all type C fractures are particularly problematic for nonunion following nonsurgical treatment (odds ratio, 7.5; 95% confidence interval, 2.3 to 24.7) (Figure 2).

Srinivasan et al[11] compared 29 surgically treated DHFs with 8 nonsurgically treated fractures, specifically focusing on an elderly cohort (average age, 85 years) with an average follow-up of 42 months. They showed notable restoration of good/excellent function, substantial pain relief, and satisfactory anatomic contour and ROM when the fractures were surgically treated. Complications among the elderly cohort, when surgically treated, were comparable with those historically reported for surgically treated younger patients. In 2011, Nauth et al[12] confirmed these observations in a pooled analysis of the DHF literature.

Indications and Contraindications

Open reduction and internal fixation (ORIF) is indicated for a DHF in any patient who can tolerate surgery and participate in therapy, with the exclusion of the extremely low-demand elderly population.[9,10] ORIF remains the standard of care for any functional patient who can undergo adequate reconstruction that allows for early functional recovery.

Benefits and Risks

ORIF provides improved outcomes by offering enhanced stability, high union rates, and early physiotherapy. However, this challenging and highly technical surgery does carry an overall 30% complication rate, including elbow stiffness, infection, wound healing problems, iatrogenic ulnar neuropathy, malunion, nonunion, osteonecrosis, and loss of fixation (Table 1).

Goals and Fixation Principles

The goal for the treatment of DHF is to achieve a painless, stable elbow with a functional ROM, permitting the recovery of independence and the ability to perform activities of daily living. This is best accomplished with restoration of anatomic alignment using early, definitive, rigid fixation (Figure 3). An anatomically aligned, but stiff, elbow can predictably undergo delayed contracture release and, hence, alignment and healing are the top priorities. It has been demonstrated repeatedly that early definitive fixation (ie, within 48 to 72 hours) improves outcomes, expedites hospital discharge, and minimizes complications. The highest complication rates, as well as the greatest level of surgical difficulties, occur in those patients managed beyond 2 to 3 weeks following the initial injury or when other procedures have been performed before definitive fixation.[20, 21]

Biomechanical Considerations

The mechanical stresses on the distal humerus during functional activity require the use of stout, rigid internal fixation. The use of one-third tubular plates, Kirschner wires, and crossed cannulated screws as fixation devices is inadequate.[22]

In the absence of strong data, controversy continues regarding optimal

Figure 3

AP radiographs of the elbow (**A**) and forearm (**B**) showing an intra-articular distal humerus fracture and ulnar shaft fracture (floating elbow) in an active 71-year-old woman with well-controlled rheumatoid arthritis who experienced a ground-level fall in the shower. Lateral forearm (**C**), AP forearm (**D**), and AP elbow (**E**) postoperative radiographs at 1 year showing fracture healing of the distal humerus, olecranon osteotomy, and ulnar shaft. **F** and **G,** Postoperative clinical photographs demonstrating range of motion at 1 year. The patient has pain-free motion and full function.

plate positioning. In recent years, parallel plating has gained favor in many biomechanical models; however, orthogonal plate placement, or 90-90 plating, maintains an excellent clinical record. Stoffel et at[23] compared various fixation constructs in AO type C fractures in paired, elderly cadavers (age, 68 to 87 years) with osteoporosis. Using either a 90-90 placement of locking compression plates or a parallel, precontoured, locked plating system, they showed that parallel locking plates had superior resistance to axial compression ($P = 0.005$) and external rotation ($P = 0.006$), whereas 90-90 plating stiffness was more dependent on bone mineral density (BMD). However, no substantial difference in torsional load to failure, the typical mode of fixation failure in this fracture, was seen. Most biomechanical studies, although not specific to the elderly population, support this finding as well. The only published, clinical study available compared 38 patients, randomized to orthogonal versus parallel plating, and found no substantial difference in ROM, function, or union.[24] Although statistically insignificant, 2 of 17 nonunions (11.8%) were seen in the orthogonal plating group compared with no nonunions in the parallel plating group. Both nonunions resulted in loosening of the posterolateral plate.[24] Proponents of parallel plating cite this finding as the major shortcoming of perpendicular plating, attributing fixation failure to the varus stresses on the construct as the arm is forward elevated in space. We typically perform 90-90 plating at our institution, especially when the fracture involves a coronal split, because past performance of the procedure has shown excellent results. Although parallel plating requires more posterolateral dissection, we are more likely to perform this procedure on distal fracture patterns to maximize distal fragment fixation.

Figure 4

Clinical photograph of patient positioning for open reduction and internal fixation. We prefer to place patients in the lateral decubitus position, securing hip positioners. The arm is placed with the elbow flexed over a firm foam support. This support can be placed on a standard arm table, or, as in our institution, on a custom-made platform.

Although locked plates are not required for younger patients with a DHF, they are preferred because they have proven to be superior for use in osteoporotic bone. Schuster et al[25] used cadavers with various bone densities to compare 90-90 plate placement using locked compression plates versus conventional reconstruction plates. They found that locking constructs are not critical in good quality bone but provided superior resistance to screw loosening when the BMD is <420 mg/cm^3.

Surgical Technique

Approach

The patient can be positioned supine, prone, or lateral; the lateral decubitus position is preferred at our institution (Figure 4). We apply a pragmatic approach, using a posterior utilitarian incision as standard for DHF fixation. The ulnar nerve should always be identified, adequately decompressed, and constantly visualized to avoid iatrogenic injury. Paratricipital mobilization is used to gain visualization of the fracture. The fracture pattern and bone quality are assessed. If fixation is possible, many type A, B, and simple type C fractures can be adequately reconstructed through this approach, and the option to safely convert to arthroplasty is maintained.[26] For OA/OTA type C2 and C3 fractures, the best articular visualization is gained by converting the paratricipital exposure into an olecranon osteotomy.[27] Risks of the olecranon osteotomy include plate irritation, leading to removal of the implant in 6% to 30% of patients, a zero to 9% rate of osteotomy nonunion, and complicated conversion to arthroplasty.[12] If the fracture is not reconstructable and requires arthroplasty, this should be performed through the paratricipital approach, avoiding an osteotomy. Although successful salvage has been described, the paratricipital approach avoids the devastating loss of the extensor mechanism.[28]

In open fractures, a triceps-splitting approach can be considered with lower removal of the implants, resulting in similar strength and improved functional outcomes.[29] This approach also allows safe transition to arthroplasty by avoiding an osteotomy.

Ulnar Nerve Transposition

Ulnar nerve transposition continues to be controversial. The benefits of transposition are increased excursion (minimizing intraoperative traction), prevention of future subluxation, and avoidance of irritation by prominent implants. However, transposition adds additional microtrauma, devascularization, and scarring to the nerve and may paradoxically cause constriction anteriorly or at the sites of inadequate release. Chen et al[30] retrospectively found an incidence of postoperative ulnar neuritis after transposition compared with in situ decompression in 16 of 48 patients (33%) and in 8 of 89 patients (9%), respectively. In addition, they noted no benefit resulted from transposition based solely on the presence of a medial plate. Vazquez et al[31] reviewed 69 patients, none of whom had preinjury ulnar nerve symptoms, and found no benefit from transposition of the nerve versus in situ decompression. Overall, however, 20% experienced ulnar nerve dysfunction at some point during convalescence, with 16% reporting symptoms persisting >1 year. In a consecutive series of 117 AO type C DHFs, Ruan et al[32] prospectively studied 29 patients identified as having preoperative ulnar nerve symptoms. A statistically significant different rate of complete nerve recovery was found between the group randomized to nerve transposition (12 of 15 patients [80%]) versus those randomized to in situ decompression (8 of 14 patients [57%]). In addition, more patients had good/excellent nerve function scores in the transposition group (86.7% versus 57.1%; $P < 0.05$). Importantly, 88 patients without preoperative ulnar nerve symptoms who were excluded from the study remained asymptomatic. The authors concluded that subfascial transposition is beneficial when preoperative symptoms are present. In our practice, we undertake transposition in the presence of preoperative symptoms or when the injury, anatomy, or implant positioning requires it.

Authors' Technique Pearls

An anatomic goal for ORIF is to restore appropriate length, alignment, and rotation. Care must be taken to never shorten the trochlea; in patients with comminution, position screws are used and bone defects are grafted to maintain trochlear width. The capitellum is often driven into the radial column, requiring disimpaction to restore articular anatomy. In the presence of supracondylar comminution, shortening of the metaphysis is acceptable. The olecranon and coronoid fossa must not be obliterated by the implant and are recreated with a burr when metaphyseal shortening exists. We use a preapplied, precontoured olecranon locking plate because we have found that this device has a lower rate of removal compared with a tension band construct. As in all articular fractures, the surgeon should verify smooth, unrestricted motion with a stable fracture construct. In addition, a free and decompressed ulnar nerve should be confirmed and satisfactory fluoroscopic images obtained before closure.

Postoperative Care

Postoperatively, a splint is applied for 3 to 7 days to allow soft-tissue healing. Multiple studies have shown inferior results when splinting is used for >2 weeks in elderly patients with DHF.[13,14,33] Active and active-assisted ROM, with a 1-lb lifting restriction, is then allowed as soft tissues heal. Strengthening and passive ROM commence at about 12 weeks postoperatively, once there are radiographic signs of healing. Patients are enrolled in a geriatric fragility program in which emphasis is placed on strength and balance training, fall prevention, medical optimization, and BMD treatment.

Outcomes

Elderly patients sustaining a DHF have poorer functional outcomes compared with physiologically young patients. Pajarinen and Björkenheim[33] showed good/excellent MEPS scores in 8 of 8 patients aged <40 years (100%) compared with good/excellent scores in only 2 of 10 patients aged >50 years (20%), citing age >50 years, osteopenia, and open fracture as independent variables associated with poorer outcome. John et al[22] published the first modern study showing good surgical results in the elderly population. He reported on 39 surviving patients (from an original cohort of 49 patients) with an average age of 80 years (range, 75 to 90 years), showing good/excellent results in 28 patients (71%). Eighty-five percent regained satisfactory function, with complication rates no higher than those found in younger patients. Notably, the use of one-third tubular plates resulted in the only implant failures. When technically possible, early rigid fixation yields favorable results, with union rates of 91% to 100%, arcs of motion averaging 19° to 126°, and acceptable functional outcomes (Table 1).

Complications

Elderly patients should be counseled regarding the adverse risks of ORIF, including heterotopic ossification, olecranon osteotomy nonunion, a need for removal of olecranon implants, and postoperative ulnar neuritis, with incidence rates of 7.2%, 2.7%, 14%, and 7.2%, respectively. In addition, a substantial rate of radiographic osteoarthritis is seen as a result of the injury itself (Table 1). Delay in definitive fixation, especially in the presence of multiple surgeries (often from inadequate surgery before a patient transfer), is strongly predictive of poor outcomes and the development of heterotopic ossification.[21,34] Early definitive rigid fixation at an experienced center and early ROM remain the standard of care.

Total Elbow Arthroplasty

History

Interposition arthroplasty was the original salvage procedure for disabling arthritis and elbow trauma. The unconstrained total elbow arthroplasty (TEA) was introduced in the mid-20th century, although the procedure was initially associated with unpredictable pain relief and predictable loosening and instability. In the 1970s, the cemented, hinged prosthesis provided improvements, but the modern evolution of the semiconstrained prosthesis has substantially improved outcomes. Early use of TEA was mostly for the treatment of rheumatoid arthritis and associated fractures. However, with the success of disease-modifying antirheumatic drugs and the increasing incidence of fragility fractures, a marked shift has occurred in recent years, with nearly 70% of TEAs currently used for trauma.[35]

Indications and Contraindications

Thoughtful, deliberate patient selection is crucial when considering TEA. Replacement arthroplasty should be reserved for fractures whose complexity (eg, comminution, articular involvement, poor bone quality) would preclude fixation secure enough to allow for early functional recovery (Figure 2). Additional indications include fracture in the presence of preexisting elbow arthritis, instability, nonunion, and malunion. Open fracture is not a contraindication to immediate arthroplasty, and satisfactory results can be expected without a marked increase in complications.[7] TEA is contraindicated in physiologically young, high-demand patients, and in those with cognitive impairment who may not be able to reliably comply with the lifelong restrictions mandated by arthroplasty. Absolute contraindications to TEA include the presence of infection, severe neurologic injury, poor soft-tissue coverage, or fractures amenable to ORIF.

Risks and Benefits

In properly selected patients, early TEA offers more predictable early return to function because it does not rely on bony healing and it preserves the extensor mechanism. Early TEA avoids complications including nonunion, malunion, and posttraumatic arthritis. However, TEA patients must learn to comply with a lifelong 10-lb lifting restriction. Moreover, the major complications of TEA, although rare, are generally more devastating than those seen with ORIF. Major complications include osteolysis, implant loosening, implant failure, periprosthetic infection, and periprosthetic fracture. Lesser complications include superficial infection, elbow stiffness, wound healing or skin breakdown problems, ulnar neuropathy, and bearing wear.

Biomechanical Considerations

The semiconstrained TEA is the most frequently reported procedure in the literature. Its "sloppy hinge" allows 6° to 8° of varus, valgus, and rotational movements, which helps offload the cement-bone interface, minimizing the major cause of loosening. This design does not rely on a radial head or collateral ligaments. In a study on using TEA for DHF, McKee et al[36] showed that condylar excision does not compromise elbow strength or motion and can decrease surgical time and complexity, as well as eliminate pain secondary to condylar nonunion.

Although nonconstrained prostheses are available and promote features such as preserving bone stock and showing less polyethylene wear, trauma applications are highly limited because these models require intact bone stock and demand delicate soft-tissue tensioning.

Authors' Technique Pearls

Patient positioning, incision, and nerve mobilization are identical to that described previously for ORIF. Using the paratricipital approach, we excise the condylar fracture fragments (saved for later anterior flange bone grafting) and release the collateral ligaments. After component insertion, ROM should approximate 0° to 150°. Closure includes repair of the triceps fascia and subcutaneous ulnar nerve transposition.

Postoperative Care

A splint is placed on the patient's elbow, which is positioned in 90° of flexion for 2 to 3 days, after which time we encourage early active and active-assisted ROM, strongly reinforcing the 10-lb lifelong lifting restriction and avoidance of high-impact activities, such as racquet sports.

Outcomes and Complications

For the use of modern implants in rheumatoid arthritis, Gill and Morrey[37] presented 5-year and 10-year survivorship rates of 94.4% and 92.4%, respectively. If similar outcomes are to be expected in trauma, careful patient selection is paramount. In the first American series of TEA for DHFs, 20 of 21 implants were intact at 3.3-year follow-up, ROM averaged 25° to 130° with an average MEPS score of 95, and results and outcomes were similar to patients with concomitant RA.[38]

In reviewing the total body of literature describing the use of TEA for DHF in the elderly population, expectations include a physiologic ROM (99.3° arc [26° to 125°]), reasonable function (average MEPS, 87), and an acceptable implant survival rate of 94% at an average of 38.5 months (Table 2). The most common complications include stable radiographic lucency (17%) and gross loosening (4.7%). More devastating complications include periprosthetic fracture (1%), implant fracture (1%), and deep wound infection (2%). Few data exist on long-term outcomes, but these outcomes are expected to be less encouraging.

Total Elbow Arthroplasty Versus Open Reduction and Internal Fixation

Several studies have directly compared TEA with osteosynthesis in the elderly population. Frankle et al[17] undertook a retrospective comparison between 12 ORIFs and 12 TEAs in women aged >65 years with type C fractures. The authors reported reduced surgical time, hospital stay, and rehabilitation time, as well as improved ROM and functional scores for TEA at short-term follow-up. Failure rates in the ORIF and TEA groups were 25% (3 of 12 patients all requiring revision to TEA) and zero percent (0 of 12 patients), respectively. In a prospective, randomized, controlled trial, McKee et al[18] evaluated 20 displaced intra-articular fractures in

Table 2

Total Elbow Arthroplasty for Distal Humerus Fractures in the Elderly Population: Pooled Outcomes Analysis[a]

Variable	Ratio or Range	Average or Percent
Age[17-19,39-47]	57–95 yr	77.5 yr
Follow-up[17-19,39-47]	—	38.5 mo
Open fracture[18,39,41-44,46]	0–7	12.5%
Preoperative nerve changes[18,42,43]	1/11	9.1%
New postoperative ulnar nerve changes[17,18,39,40,42,43,45]	26/235	11%
ROM[17-19,40-47]	26°–124.7°	99.3° arc
MEPS[17-19,39,41-45,47]	—	87.1
Instability[39-44,46,47]	0/22	0%
Loosening[17-19,39,40,42-46]	11/235	4.7%
Stable radiolucent lines[17-19,39,40,42-46]	40/235	17.0%
Progressive radiolucent lines[17-19,39,40,42-46]	5/235	2.1%
Periprosthetic fracture[44,46]	2/235	0.9%
Implant fracture[39,40,44,46]	2/235	0.9%
Implant survival[17,19,39-41,46,47]	220/235	93.6%
Surgical time[18,39]	—	118.4 min
Length of stay[18,41,42,45]	—	8.5 d
Heterotopic ossification[18,39,40,42,43,45]	39/235	16.6%
Superficial wound problems[18,39,40,43,44]	11/235	4.7%
Deep infection[17,18,39,43]	5/235	2.1%
Hematoma[17,18,39,43]	6/235	2.6%

MEPS = Mayo Elbow Performance Score, ROM = range of motion
[a] 12 studies, 235 patients

Figure 5

AP postoperative radiograph of the elbow demonstrating a stable distal humerus hemiarthroplasty with healing of the bony columns and olecranon osteotomy in an elderly patient who sustained a very distal, unreconstructable, intra-articular distal humerus fracture. (Copyright Rick Papandrea, MD, Pewaukee, WI.)

patients aged >65 years. Results showed statistically lower surgical time (140 versus 108 minutes; *P* = 0.001), improved Disabilities of the Arm, Shoulder and Hand scores from zero to 6 months (*P* = 0.01), and improved MEPS at all time points (3 months, *P* = 0.01; 6 months, *P* = 0.003; 12 months, *P* = 0.007; 2 years, *P* = 0.015) in those who underwent TEA. A statistically insignificant trend toward improved motion and lower reoperation was found in the TEA group versus the ORIF group (27% and 12%, respectively). Importantly, five patients randomized to ORIF were converted to TEA intraoperatively when extensive comminution precluded adequate fixation. Nauth et al[12] conducted a pooled analysis and showed higher good/excellent functional outcomes in TEA (89% versus 76%) with no difference in complication rates. Githens et al[48] presented a meta-analysis showing similar functional outcome and ROM with a statistically insignificant trend toward higher major complication and reoperation rates in elderly patients undergoing ORIF compared with TEA but concluded that the quality of the included studies was weak.

Distal Humerus Hemiarthroplasty

The indications for distal humerus hemiarthroplasty are narrow, and defining patient qualifications is beyond the scope of this article. Distal humerus hemiarthroplasty requires an anatomic distal humerus component, an intact coronoid process and radial head, and good healing potential of the collateral ligaments. Some authors believe hemiarthroplasty is indicated in physiologically younger, high-demand patients when ORIF is not possible (Figure 5). Theoretical benefits include shorter surgical times, lower rates of loosening, avoidance of polyethylene wear, better durability, and avoidance of the lifting restrictions. An increased risk of instability and ulnar wear are the major concerns. Orthopaedic surgeons should be reminded that rigorous studies are lacking and, currently, no US Food and Drug Administration-approved implants are available in the United States.

Summary

The prevalence of DHF is increasing in the elderly population and presents a unique group of challenges to the orthopaedic surgeon. Nonsurgical treatment can offer acceptable outcomes for frail and medically unfit patients who are unable to tolerate surgery or comply with rehabilitation. Although ORIF is the preferred procedure and remains the goal for all fractures amenable to rigid anatomic fixation, this procedure is not possible in approximately 25% of patients.[17,18] When ORIF is not attainable, TEA remains a good option, with good early outcomes in very low-demand elderly patients who are able to comply with rehabilitation and lifelong lifting restrictions.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, references 18, 24, and 32 are level I studies. References 12, 20, and 26 are level II studies. References 1-3, 6, 11, 17, 19, 29-31, 36, and 48 are level III studies. References 7-10, 13-16, 21, 22, 33-35, and 37-47 are level IV studies. Reference 28 is level V expert opinion.

References printed in **bold type** are those published within the past 5 years

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